no hesitation in stating that he is certainly justified in hoping, as he does in the preface, "that the present volume may . . . further the advancement of, and prove not altogether unworthy of, the present position of Physiology in England." J. S. EDKINS.

AN ESSAY ON NEWTON'S "PRINCIPIA."

An Essay on Newton's "Principia." By W. W. Rouse Ball. (London: Macmillan and Co., 1893.)

THE name of Newton has become now quite a household word amongst us, and one instance of its familiarity was strikingly brought home in an answer given by a small child, who when asked who was Newton, replied, "the man who found the first apple!" That two important epochs in the world's history should have been marked by the presence of this fruit, seems curious indeed; and Mr. Ball informs us that the apple anecdote in Newton's case rests on good authority, for besides written evidence, local tradition confirms it by the careful treatment the tree received, which kept it alive until the year 1820.

For the essay which we have before us, Mr. Ball should receive the thanks of all those to whom the name of Newton recalls the memory of a great man. The "Principia," besides being a lasting monument of Newton's life, is also to-day the classic of our mathematical writings, and will be so for some time to come. During Newton's lifetime three editions of this great work were brought out, the first appearing in 1687; the second, edited by Cotes, in 1713; and the third, by Pemberton, in 1726. Since the last-mentioned date, the history of the "Principia" has been discussed by Sir David Brewster and Prof. S. P. Rigaud, but both of these works are now out of print and very scarce. At the present time, as Mr. Ball informs us, it seems fitting to collect, from these and other sources, the references to the leading events in the preparation and publication of the "Principia," and the present volume contains the result of his labours. In the subject-matter, of course, there is much that is not new, but the value of the work lies in the fact that, besides containing a few as yet unpublished letters, there are collected in its pages quotations from all documents, thus forming a complete summary of everything that is known on the subject.

Mr. Ball divides his essay into six main sections, dealing with Newton's investigations in 1666, in 1679, in 1684, in 1685–1687, compilation and publication of the "Principia," the two last treating of the contents of the "Principia," and the subsequent history and preparation of later editions.

Mr. Ball commences with the works of Newton at the time when the latter had taken his degree at Cambridge, and therefore had more leisure to pursue his studies in his own way. The reader is made acquainted with Newton's early views, and there are several interesting quotations from some original manuscripts inserted. The investigations of 1879 refer, in great part, to the correspondence he had with Hooke, which turned his attention to the problem of planetary motion. It was in this year that Newton suggested the method of demonstrating the earth's motion of rotation on its axis by the letting fall of a stone from a high position, and observing the direction of the deviation from the vertical; he also repeated his calculations (with new data) for finding the relation between terrestrial gravity and the centripetal force which retained the moon in her orbit.

In 1684, Halley, after attempting to deduce the motion of the heavenly bodies from Kepler's laws, with unsuccessful results, made a visit to Cambridge, when he found that Newton "had brought this demonstration to perfection." During that year Newton gave in his professional lectures an account of his work then in manuscript form, entitled, "De Motu Corporum," which may be said to be "a rough draft of the beginning of the first book of the 'Principia.'" This period includes also Halley's second visit to Cambridge with reference to Newton's publication of this tract, and it was at this time also that Halley asked him to communicate his results to the Royal Society. The tract which Newton finally communicated was entitled, "Propositiones de Motu," and may be looked upon as marking the point at which Newton had arrived about the end of this year. Mr. Ball reproduces this tract *in extenso*, as it has only once been printed, and copies of it are scarce.

The fifth chapter deals with the investigations from 1685 to 1687, during which time Newton was preparing the "Principia." A most interesting account is given of the details concerned in the preparation of the subject-matter, while he refers also, by no means too fully, to the extreme generosity that Halley displayed, both as regards the cost of printing the books, and also to the interest he took in their progress, criticising some parts, and revising sheets for press. Rigaud, in his essay on the first publication of the "Principia," referring to this point, says, "that under the circumstances it is hardly possible to form a sufficient estimate of the immense obligation which the world owes in this respect to Halley, without whose great zeal, able management, unwearied perseverance, scientific attainments, and disinterested generosity the 'Principia' might never have been published." Mr. Ball also discusses here briefly Newton's controversy with Hooke, "the universal claimant," as he was called.

Chapter vi. is devoted to an analysis of the "Principia," a few words of introduction relating to the main differences between the first editions being given. Mr. Ball limits himself in the main to a statement of the propositions, lemmas, &c., but occasionally he breaks in with a few words of explanation, or of historical interest.

The remaining period, ending with the year 1726, contains matter dealing with the large correspondence Newton had on the contents of his "Principia," to his revision of the whole work, the extension of some of the results, and finally to the preparations of the two later editions.

The appendices contain the correspondence between Newton and Hooke and Halley, besides some memoranda on the correspondence concerning the production of the second and third editions.

From the above brief sketch of the contents of this essay, our readers may perhaps gather some idea of the ground it covers. The author is so well known a writer on anything connected with the history of mathematics, that we need make no mention of the thoroughness

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of the essay, while it would be superfluous for us to add that from beginning to end it is pleasantly written, and delightful to read. Those well acquainted with the "Principia" will find much that will interest them, while those not so fully enlightened will learn much by reading through this account of the origin and history of Newton's greatest work.

WELLS ON ENGINEERING DESIGN.

Engineering Drawing and Design. By Sydney H. Wells, Wh.Sc., A.M.Inst.C.E. In Two Parts. (London: Chas. Griffin and Co., Ltd., 1893.)

THIS book is intended for the use of engineering students in schools and colleges, and as a text-book for examinations in which a knowledge of practical geometry and machine drawing is required. The author says in the preface that the chief reason which has led to its preparation is that during the time he was engaged in teaching on the engineering side of Dulwich College, he found it impossible to obtain a suitable text-book.

The work is published in two parts. Vol. i. deals with the geometrical part of the subject, but includes many references to practical questions and machinery wherein is to be found the applications of the particular geometrical construction. In the earlier treatment of this subject we find much excellent instruction for beginners, written in a clear and concise manner. The methods of construction described are all clearly illustrated, and appear to have been chosen from the best examples.

Vol. ii. deals with "machine and engine drawing and design." In the preface we find the following statement: "A student ought not to be told the sizes of bolts and nuts, or the diameter of flanges, or the details of stuffing-boxes, in drawing an engine cylinder, any more than we should expect to have to prove to him the truth of the triangle of forces, at each step in the graphical determination of the stresses in a roof truss." This statement evidently comes from the technical school view of mechanical engineering. The triangle of forces is certainly a safe assumption; but to allow one of Mr. Wells' students fresh from college to run wild in a drawing-office of an engineering works where standards are the rule, and not the exception, would be a treat not to be missed. No doubt he could turn out an excellent "technical school" drawing, but whether it would "pay" is another matter. A draughtsman generally has standards for flanges, glands, studs, &c. for an engine cylinder. Notwithstanding this, we congratulate the author on the contents of vol. ii. of his book; he has gone as far as he can to lead his students into the way of being draughtsmen; and of course this, after all, can only be accomplished—or, rather, completed—in the drawing-office of a mechanical engineer.

For the many examples and questions included in the second part we have nothing but praise; they are taken from every-day practice, and are amply elucidated. On page 183 we are told that copper pipes are made from malleable sheets, and may be as thin as $\frac{1}{16}''$. Very few copper pipes of small diameters are now used by engineers made in this way; they are usually solid drawn When iron or copper pipes require flanges, these are generally brazed to the pipes; screwed flanges with lock-nuts are seldom, if ever, used. Unions for small brass and copper pipes are usually brazed, and not screwed on the pipes, as shown in Fig. 124*d*.

Section 26, on steam engine design, is well done. It is quite refreshing to find in a text-book of this kind that questions of manufacture and shop practice are considered worthy of notice; as a rule, such details are carefully omitted—to the student's loss. The piston-rings shown in Fig. 180*a* are far too narrow for general work; and again, in Fig. 187, illustrative of a crosshead for a single slipper guide, the slipper is far too light for its work, besides being defectively attached to the crosshead. Further on, in Fig. 191, showing a connecting-rod end, surely the author would not recommend the strap to be machined out square at the corners as shown; the much-abused "practical man" would put in a radius instead, and by so doing increase the strength considerably. The brasses are also shown apart; whereas they must be tightly brought together for the type of rod end illustrated.

Beyond these few points, the two volumes are exceedingly well written, and will be of great use to students in our technical colleges. The author has taken great pains to ensure the clearness of his descriptions, and has succeeded in producing a thoroughly useful work.

N. J. LOCKYER.

THE EGYPTIAN COLLECTIONS AT CAMBRIDGE.

Catalogue of the Egyptian Collection in the Fitzwilliam Museum. By E. A. Wallis-Budge, Litt.D. (Cambridge: University Press, 1893.)

WE recently noticed at some length Dr. Wallis-Budge's book entitled "The Mummy," and mentioned that it was intended as an introduction or a supplement to his catalogue of the antiquities which belong to the University. The catalogue itself is now before us, and is, as might be expected, a scholarly piece of work. There are people who like to read catalogues; to them this volume should prove to be of greater interest even than its companion "The Mummy"; but fortunately tastes differ, and we confess that, except perhaps to a scholar of endowments equal to those of Dr. Budge himself, "The Mummy" is the better of the two. It is satisfactory, however, to remember that the Fitzwilliam collection has been duly catalogued by competent hands, and that this catalogue is now published in an accessible form, Cambridge thus taking the lead among English universities in allowing the world to know what treasures it possesses of ancient Egyptian art. This knowledge is very valuable to the student. How many of us, for example, have seen and admired at the Louvre the granite sarcophagus of Rameses III.? Yet how few of us have known till now that the lid of the same coffin is at Cambridge? When Oxford has published a catalogue like this, and when the British Museum has followed suit, the cross references from one collection to another will in

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